**Remarks**

Claims 1-5 were pending in this application. Claims 2 and 3 have been cancelled, and claims 1 and 5 have been amended. Accordingly, claims 1 and 4-5 are presently being examined.

Section 1 of the Office Action objected to Figs. 2-4 as not being clear and required correction.

Applicants hereinabove have amended the drawings to replace Figs. 2-4 to more clearly show the subject matter of the present invention shown in original Figs. 2-4 as required in the Office Action. Replacement Figs. 2-4 also add descriptive labels "1 mm" to indicate the thickness of the metal, and replacement Fig. 4 further adds descriptive labels "Aluminum" and "Copper" to indicate the metal types. Support for these amendments can be found, inter alia, in original Figs. 2-4 and on page 5 in lines 5-14 of the subject specification. Applicants respectfully submit that no new matter has been introduced by the drawing amendments.

In view of the remarks above, the amendments to Figs. 2-4 and the Replacement Sheet in Exhibit A, applicants respectfully request that the objections to Figs. 2-4 be reconsidered and withdrawn.

Section 2 of the Office Action objected to claim 5 under 37 C.F.R. §1.75(c) as being in improper form because, as a dependent claim, it fails to limit the subject matter of a previous claim.

Applicants hereinabove have amended claim 5 to further limit the previous claim by reciting that the "work pieces are made of different materials" instead of "the same or different materials". Accordingly, applicants respectfully submit that amended claim 5 further limits amended claim 1, and thus, is not in improper form.

In view of the remarks above and the amendments to claim 5, applicants respectfully request that the objection to claim 5 as

being in improper form be reconsidered and withdrawn.

Sections 3 and 4 of the Office Action rejected claims 1 and 5 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 5,813,592 to Midling et al. ("Midling patent").

More specifically, the Office Action stated that the Midling patent teaches all the elements of the friction stir welding process recited in claim 1.

The present invention describes and recites in amended claim 1 a "no-pin" probe. This probe permits formation of a weld without the undesirable "keyhole" effect, that is, empty space usually at the trailing edge of the welded joint. In other words, one joining principle and method of the present invention for welding workpieces can be described as 'without a pin and without leaving a keyhole'. The present invention accomplishes this goal by producing intense plastic deformation only at the surfaces of the workpieces and thereby causing the plastic deformation to permeate the inner material of the workpieces.

In contrast, the Midling patent describes an ordinary method of friction stir welding for joining members by insertion of a probe comprising a rotational cylindrical body having an upper part 22, a bottom part 23, often called a "shoulder", "provided with a separate pin 24". The pin fits between the members and under predetermined pressure and rotation provides frictional heating for a butt seam weld during a transitional movement along the line of the butt-arranged members. According to the Midling patent, frictional heating takes place at two portions: one is "at the top surface" by rotation of the shoulder 23; and the other one is "in the line of opening between the members" to be joined by rotation of the pin 24. Figs. 1, 3, and 5a of the Midling patent explicitly show the existence of a pin to be inserted into the line of opening

between the butt-arranged members.

In contrast, the present invention has no pin for insertion into a butt-arranged opening between members to be joined. Instead, frictional heating takes place "only at the top surface" along the line of butt-arranged members, while the forcible and intense plastic deformation at the surfaces permeates into the narrow line of the opening between the butt-arranged members. In this way, the unwanted inherent problem of keyholes (welding defects) using the traditional friction stir welding method described by the Midling patent can be avoided. As described on page 3 in lines 4-11 and page 4 in lines 3-10 of the present specification, the keyhole problem of conventional friction stir welding arises due to the presence of the probe pin, and one purpose of the present invention is to resolve this problem by providing at least one new joining principle and method to weld a workpiece only with a probe, that is, without using a traditional pin.

Applicants hereinabove have amended claim 1 to more clearly recite that the probe has "no pin" and, from cancelled claim 2, has a diameter at least twice the "thickness of the workpiece". Support for this amendment can be found, inter alia, on page 8 in lines 7-24 of the present specification.

Claim 5, as amended, depends directly or indirectly on amended claim 1. Because a claim which depends on another claim is subject to all the limitations of that other claim, applicants respectfully submit that amended claim 5 is not anticipated by the Midling patent for at least the same reasons discussed above with respect to amended claim 1.

In view of the remarks above, and the amendments to claims 1 and 5, applicants respectfully request that the rejection of claims 1 and 5 as being anticipated by the Midling patent be reconsidered

and withdrawn.

Section 5 of the Office Action rejected claims 1, 2, and 5 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,585,148 to Aono et al. ("Aono patent").

More specifically, the Office Action stated that the Aono patent teaches a conventional friction stir welding process as described in claim 1 and that the probe has a diameter more than twice the thickness of the workpieces as described in claim 2.

Applicants respectfully submit that the Aono patent relates to a process for welding iron-base materials, where the iron-base material is fine-grained material and free from any amorphous phase. The Aono patent describes a high-speed-rotating tungsten bar tool 4 which is inserted into a weld part and moved along a weld line 5 to conduct friction stir welding. In other words, a probe pin, the bar tool, is inserted in the weld line part.

In contrast and as discussed above with respect to the Midling patent, the present invention as recited in amended claim 1 differs from the Aono patent at least because no pin probe is employed by the recited method.

Also, applicants hereinabove have cancelled claim 2. Accordingly, applicants respectfully submit that the rejection of claim 2 is now moot.

In view of the remarks above, the amendments to claims 1 and 5, and the cancellation of claim 2, applicants respectfully request that the rejection of claims 1, 2, and 5 as being anticipated by the Aono patent be reconsidered and withdrawn.

Section 6 of the Office Action rejected claims 1 and 3 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent Application Publication No. 2005/0035179 to Forrest et al. ("Forrest publication").

More specifically, the Office Action stated that the Forrest publication teaches a double pass friction stir welding process as described in claims 1 and 3 where members are joined by traversing the probe in a horizontal directional along the interface with a small probe.

While the Forrest publication illustrates another forming apparatus in which a workpiece is welded (formed) by two friction stir welding tools opposed to each other, each of the tools includes a shoulder 42a and 42b and a "pin (44a, 44b) extending therefrom" as shown in Fig. 4 and Fig. 5 of the Forrest publication.

In contrast, while the present invention describes double pass welding on page 8 in lines 2-6 of the present specification, as recited in amended claim 1, the probe of the present invention has no pin. Instead, the present invention only uses the surface friction of the probe against the workpieces to cause the generation of plastic flow. Accordingly, the present invention advantageously achieves the welding of thin sheets which are difficult to weld with the existing friction stir welding. Thus, the present invention produces welded sheets having no welding defects conventionally caused at the trailing edge of the weld joint region due to the use of a probe pin.

Also, applicants hereinabove have cancelled claim 3. Accordingly, applicants respectfully submit that the rejection of claim 3 is now moot.

In view of the remarks above, the amendment of claim 1, and the cancellation of claim 3, applicants respectfully request that the rejection of claims 1 and 3 as being anticipated by the Forrest publication be reconsidered and withdrawn.

Section 7 of the Office Action rejected claims 1 and 4 under

35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,726,084 to Duncan, Jr. ("Duncan patent").

More specifically, the Office Action stated that the Duncan patent teaches a conventional friction stir welding process as described in claims 1 and 4 where members are joined by traversing the probe in a horizontal directional along the interface with the know method of double pass welding with a smaller pin and where the probe has a plurality of protrusions.

Applicants respectfully submit that while the Duncan patent describes a friction stir welding process for joining members using a cylindrical body, the Duncan patent requires that the body be "provided with a separate pin protruded therefrom". Since, as recited in amended claim 1, no pin exists in the present invention, the probe of the present invention is different from that of the invention described in the Duncan patent.

With regard to claim 4, while the depth of the plasticised region, which is produced by surface friction, is a factor determining the weldable thickness of the two work pieces, the depth of the plasticised region is proportional to the diameter of the probe. Accordingly, the greater the diameter of the probe, the thicker the weldable thickness of the workpiece sheets as shown in the Equation at page 7 in line 1 of the present specification. However, increasing the size of the welding portion can be problematic. Accordingly, in order to increase the coefficient of the friction of the probe, the probe of the present invention, as recited in claim 4, may be formed with a plurality of fine protrusions at the lower end surface thereof for contacting the workpieces.

In contrast, the plurality of protrusions formed at the end of the pin described in the Duncan patent for getting more friction

heat early on in the process, generates heat inside the weld joint. Accordingly, the role and effect of the protrusions formed on the pin of the Duncan patent is different from those of the present invention.

In addition, claim 4 depends directly or indirectly on amended claim 1. Because a claim which depends on another claim is subject to all the limitations of that other claim, applicants respectfully submit that claim 4 is not anticipated by the Duncan patent for at least the same reasons discussed above with respect to amended claim 1.

In view of the remarks above and the amendments to claims 1, applicants respectfully request that the rejection of claims 1 and 4 as being anticipated by the Duncan patent be reconsidered and withdrawn.

Section 8 of the Office Action rejected claims 1 and 3-5 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,676,004 to Trapp et al. ("Trapp patent").

More specifically, the Office Action stated that the Trapp patent teaches a conventional friction stir welding process as described in claims 1 and 4 where members are joined by traversing the probe in a horizontal direction along the interface with the know method of double pass welding with a smaller pin and where the probe has a plurality of protrusions.

Applicants respectfully submit that Trapp patent relates to a conventional friction butt-welding process which attempts to avoid pin breakage. However, since the process of the present invention does not employ a pin, the tool material and/or shape of the pin are unrelated with respect to the present invention recited in claim 1.

In view of the remarks above, the amendment of claims 1 and 5,

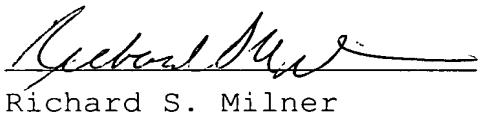
the dependency of claim 4 on amended claim 1, and the cancellation of claim 3, applicants respectfully request that the rejection of claims 1 and 3-5 as being anticipated by the Trapp patent be reconsidered and withdrawn.

In view of the remarks above, the amendments to claims 1 and 5, and the cancellation of claims 2 and 3, applicants respectfully submit that the objections and rejections raised in the Office Action have been overcome and earnestly solicit allowance of the application.

If a telephone interview would be of assistance in advancing prosecution of the subject application, applicants' undersigned attorney invites the Examiner to telephone him at the number provided below.

No fee is deemed necessary in connection with the filing of this Amendment. However, if any fees are required, authorization is hereby given to charge the amount of any such fee to Deposit Account No. 03-3125.

Respectfully submitted,



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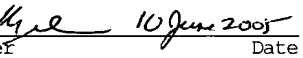

10 June 2005

Richard S. Milner
Reg. No. 33,970

Date

**Amendments to the Drawings:**

Please replace the original drawing sheet containing original Figs. 2-4 with the Replacement Sheet containing replacement Figs. 2-4 attached in Exhibit A.

Replacement Figs. 2-4 also add the descriptive label "1 mm" to indicate the thickness of the metal sheet, and replacement Fig. 4 adds the descriptive labels "Aluminum" and "Copper" to indicate the metal types.